## REMARKS

Claims 17-34 are pending herein. By the Office Action, claims 17-34 are rejected under 35 U.S.C. §103(a). By this Amendment, claims 23 and 33 are amended. Claim 23 is amended solely to correct a typographical error. Support for amended claim 33 can be found in the specification at, for example, page 7, lines 5-12; page 26, lines 17-19; and page 32, lines 8-11. No new matter is added. Applicants respectfully request reconsideration in view of the above amendments and the following remarks.

I. §103 Rejections

A. Furukawa and Kai

Claims 17-20, 22, 24-31 and 34 are rejected under 35 U.S.C. §103(a) over Furukawa in view of Kai. The Office Action argues that the claimed invention would have been obvious over the cited references. Applicants respectfully traverse this rejection.

1. Claims 17-20, 22, 24-25, and 29

Independent claim 17 is directed to a method of producing a bonded wafer comprising bonding a bond wafer made of silicon single crystal and a base wafer via an oxide film or directly and then reducing thickness of the bond wafer, wherein the base wafer is a wafer produced by processes comprising slicing a silicon single crystal ingot, and then subjected at least to chamfering, lapping, etching, mirror polishing and cleaning, and the etching process is conducted by subjecting the wafer to alkali etching, and then acid etching, and an etching amount in the alkali etching is larger than an etching amount in the acid etching. Such a method is not taught or suggested by the cited references.

According to claim 17, the base layer is produced by slicing a silicon single crystal ingot, and then is subjected at least to chamfering, lapping, etching, mirror polishing and cleaning, and the etching process is conducted by subjecting the wafer to alkali etching, and then acid etching, and an etching amount in the alkali etching is larger than an etching

amount in the acid etching. At least these features distinguish the claimed invention over a combination of Furukawa and Kai.

With respect to the claimed etching process, the specification describes that a problem was identified in the art that is addressed by the claimed invention. In particular, the specification describes at page 4, line 20 to page 5, line 20, that if acid etching is conducted for a wafer to be used as a base wafer in the bonding method, then there is a problem that flatness is degraded, and the like. At the same time, however, the specification describes at page 6, lines 1-19 and page 8, line 22 to page 9, line 9, that if an alkali etching is conducted, then another problem exists that the shape of unevenness of the surface at a chamfered part of the base wafer is sharp. As a result, the unevenness itself becomes the cause to generate fine particles, which are detrimental to the production process.

Recognizing the above-described problems, the present inventors developed the claimed invention. To solve those problems, the claimed invention uses a base wafer subjected to alkali etching, and then acid etching, in which an etching amount in the alkali etching is larger than an etching amount in the acid etching. The specification describes that by bonding the bond wafer to a base wafer produced as described above and then reducing its thickness, according to the claimed invention, it is possible "to produce a high quality bonded wafer having high flatness, excellent in thickness uniformity of SOI layer or silicon active layer and generates almost no particles." See specification at page 11, lines 11-16.

Furukawa and Kai, alone or in combination, fail to teach or suggest either the problems recognized by the present inventors, or the claimed method for solving those problems.

Furukawa is cited as disclosing the claimed invention, except for the process steps (etching) taken before bonding the base wafer. However, Furukawa merely refers to a problem that while bonding a bond wafer and a base wafer by bonding jigs, heavy metal

impurities such as Fe, Cr, and Ni become attached to the wafer and then diffuse into the wafer while annealing. However, in Furukawa, the heavy metal impurities originate from the bonding jig. See Furukawa at col. 1, lines 22-24 and 43-48. Furukawa then discloses that after a baking step at a low temperature (about 80°C or about 100°C), the heavy metal impurities attached to the surface of the bonded wafer can be removed by cleaning with hydrofluoric acid. See Furukawa at col. 2, lines 29-33 and 53-57, and col. 5, lines 31-37 and 57-59.

On the other hand, Kai discloses that a semiconductor wafer planarized by lapping is subjected to an alkali etching. Kai discloses that metal contaminants, which are either not removed during the alkali etching or are newly formed during the alkali etching, can be removed by using an aqueous solution of hydrofluoric acid or diluted mixed acid, or by using warm water. See Kai at col. 1, line 63 to col. 2, line 7 and claims 1-5.

Accordingly, Furukawa and Kai each separately discloses removal of heavy metal impurity contamination from a bonded wafer surface or a semiconductor wafer surface by acid cleaning. However, this acid cleaning is entirely distinct from the acid etching of the claimed invention. Furukawa and Kai, even if combined, do not teach or suggest the features of claim 17 that a bonded wafer, which has high flatness and generates almost no particles, is produced by using the base wafer subjected to alkali etching and then acid etching, in which an etching amount in the alkali etching is larger than an etching amount in the acid etching.

Still further, although Furukawa and Kai both teach removal of heavy metal impurity contamination from a bonded wafer surface or a single wafer surface by acid cleaning, the respective processes of Furukawa and Kai are completely different from each other. Accordingly, one of ordinary skill in the art would not have been motivated to combine these different teachings to practice the claimed invention.

Furukawa addresses the problem of removing metal contamination of a bonded wafer caused by the bonding jig used to bond a bond wafer and a base wafer. In Furukawa, the base wafer in question has already been subjected to lapping, etching and mirror polishing. Kai, however, teaches to remove remaining metal contamination by acid cleaning after a lapped wafer is subjected to alkali etching. Therefore, even if metal contamination of a wafer after alkali etching, but before bonding, is removed by acid cleaning as taught by Kai, that teaching does not lead to removing metal contamination of a bonded wafer after bonding, as in Furukawa. That is, the wafer subjected to alkali etching and acid cleaning as taught by Kai, cannot solve Furukawa's problem that metal contamination exists after and as a result of the bonding process. Nor does Kai provide the necessary motivation for one of ordinary skill in the art to have used Kai's wafer as a base wafer in the process of Furukawa.

Even if one of ordinary skill in the art were to have combined Kai and Furukawa, despite the lack of any motivation to do so, the result would at most be to remove heavy metal contamination of a bonded wafer originating from the bonding jig. The combination, however, would merely be for the skilled artisan to substitute the mixed acid or warm water of Kai for the hydrofluoric acid cleaning of Furukawa to remove such heavy metal contaminants. The result would not be to combine Kai's wafer into Furukawa's process as a base wafer.

Accordingly, for at least these reasons, independent claim 17 would not have been taught or suggested by Furukawa and Kai. Dependent claims 18-20, 22, 24-25, and 29 depend from claim 17, and are patentable for at least the same reasons as claim 17, as well as for the additional limitations that they contain.

2. Claims 26-28 and 30

Independent claim 26 is directed to a method of producing a bonded wafer comprising bonding a bond wafer made of silicon single crystal and a base wafer via an oxide film or

directly, and then reducing thickness of the bond wafer, wherein the base wafer is a wafer produced by processes comprising slicing a silicon single crystal ingot, and then subjected at least to chamfering, lapping, etching, mirror polishing and cleaning, and the etching process is conducted by subjecting the wafer to acid etching, and the mirror polishing process is conducted on both surfaces. Such a method is not taught or suggested by the cited references.

According to claim 26, the base wafer is a wafer produced by slicing a silicon single crystal ingot, and then is subjected at least to chamfering, lapping, etching, mirror polishing and cleaning, and the etching process is conducted by subjecting the wafer to acid etching, and the mirror polishing process is conducted on both surfaces. At least these features distinguish the claimed invention over a combination of Furukawa and Kai.

Furukawa and Kai are discussed above. Furukawa describes that a base wafer is a mirror polished wafer. See at least Furukawa at claim 1 and col. 5, line 56. However, Furukawa specifically teaches that the base wafer has one side of a single mirror face. See col. 1, lines 24-26. Furukawa thus teaches only a base wafer with a mirror surface on a single mirror face, and does not teach or suggest that the mirror polishing process is conducted on both surfaces, as claimed. In fact, Furukawa's disclosure of a single-side mirror polished wafer corresponds to the general state of the art, such as is described in the present specification at page 4, line 20 to page 5, line 5. Nowhere does Furukawa teach or suggest any reason for mirror polishing both surfaces of the base wafer, or that such a modification would provide any benefits to the base wafer.

Kai does not overcome the deficiencies of Furukawa. Kai describes polishing an acid-cleaned wafer. See col. 3, lines 3-37 and claim 1. However, Kai, like Furukawa, does not teach or suggest mirror polishing both surfaces of the base wafer, and does not teach or suggest any reason for modifying the disclosed process to practice the claimed invention.

Moreover, for all of the reasons described above, neither Furukawa nor Kai provide any motivation to use the wafer of Kai as the base wafer of Furukawa.

Accordingly, for at least these reasons, independent claim 26 would not have been taught or suggested by Furukawa and Kai. Dependent claims 27-28 and 30 depend from claim 26, and are patentable for at least the same reasons as claim 26, as well as for the additional limitations that they contain.

3. Claim 31

Independent claim 31 is directed to a bonded wafer having a base wafer wherein back surface is chemically etched, a chamfered part is mirror surface, and the chemically etched back surface is subjected to acid etching following to alkali etching. Such a bonded wafer is not taught or suggested by the cited references.

According to claim 31, the base wafer of the bonded wafer is subjected to acid etching following to alkali etching. Such a bonded wafer is produced substantially employing a base wafer subjected to alkali etching followed by acid etching, as described above with respect to the method of claim 17. Thus, for essentially the same reasons as described above with respect to claim 17, the bonded wafer of claim 31 would not have been obvious over Furukawa and Kai.

Accordingly, for at least these reasons, independent claim 31 would not have been taught or suggested by Furukawa and Kai.

4. Claim 34

Independent claim 34 is directed to a bonded wafer wherein at least a back surface and a chamfered part of the base wafer are mirror surface. Such a bonded wafer is not taught or suggested by the cited references.

According to claim 34, the base wafer of the bonded wafer has at least a back surface and a chamfered part of that are mirror surfaces. Such a bonded wafer is produced

substantially employing a base wafer that is subjected to acid etching and then mirror polishing both surfaces, as described above with respect to the method of claim 26. Thus, for essentially the same reasons as described above with respect to claim 26, the bonded wafer of claim 34 would not have been obvious over Furukawa and Kai.

Accordingly, for at least these reasons, independent claim 34 would not have been taught or suggested by Furukawa and Kai.

5. Conclusion

Furukawa and Kai, alone or in combination, would not have rendered obvious the claimed invention. Reconsideration and withdrawal of the rejection are respectfully requested.

B. Furukawa, Kai and Miyazaki

Claims 21, 23 and 32-33 are rejected under 35 U.S.C. §103(a) over Furukawa in view of Kai, and further in view of Miyazaki. The Office Action argues that the claimed invention would have been obvious over the cited references. Applicants respectfully traverse this rejection.

Furukawa and Kai are discussed in detail above. Miyazaki is cited for its disclosure of a method of wafer preparation that includes use of an alkaline solution to etch 0.1 to 30 microns followed by an acid solution to etch 15 to 50 microns. However, despite these disclosures, any combination of the cited references would not have rendered obvious the claimed invention.

1. Claims 21 and 23

Dependent claim 21 depends from claim 17, and specifies that the etching amount is 10 to 30 μm in the alkali etching and 5 to 20 μm in the acid etching. Claim 23 depends from claim 21. Such methods would not have been obvious over the cited references.

Miyazaki discloses that a semiconductor wafer is cleaned in an alkaline aqueous solution after lapping, such that the surface of the semiconductor wafer is dissolved in an amount of at least 4 microns, and then the wafer is subjected to acid etching. In the Example at col. 3, line 46 to col. 4, line 40, Miyazaki discloses that the surface of the silicon wafer is dissolved in an amount of from 0.1 to 30 microns, and the silicon wafer is then acid etched in an etching amount of from 15 to 30 microns.

However, Miyazaki does not describe, teach or suggest that an etching amount of alkaline etching is larger than an etching amount of acid etching, as required in independent claim 17, described above. Miyazaki merely provides two separate ranges for the alkaline and acid etching, but does not teach or suggest any particular relationship between those two ranges, as claimed. In the absence of any such teachings, one of ordinary skill in the art would not have been motivated to select from the broad ranges of Miyazaki, the specific amounts and relationships required in present independent claim 17 and dependent claim 21.

Furthermore, there is no teaching or suggestion in Miyazaki to use the disclosed wafer as a base wafer in the methods of Furukawa or Kai. Using the wafer of Miyazaki in the process of Furukawa, would not have solved the described problem of Furukawa of preventing metal contamination caused by the bonding jig. Thus, one of ordinary skill in the art seeking to improve upon Furukawa's process would not have been motivated to employ the wafer of Miyazaki as a base wafer for a bonded wafer, since such a modification would not address Furukawa's problem.

Accordingly, for at least these reasons, claim 21 would not have been taught or suggested by Furukawa, Kai and Miyazaki. Dependent claim 23 depends from claim 21, and is patentable for at least the same reasons as claim 21, as well as for the additional limitations that it contains.

2. Claims 32 and 33

Independent claim 32 is directed to a bonded wafer wherein a back surface of its base wafer is chemically etched and a chamfered part is mirror surface, and on the chemically etched back surface, the maximal depth of the pit is 6μm or less and the average value of waviness is 0.04 μm or less. Independent claim 33 is directed to a bonded wafer wherein waviness having a wavelength of 10 mm on a back surface of its base wafer is 0.5 to 10 $\mu m^3$ as power spectrum density. Such a bonded wafer is not taught or suggested by the cited references.

However, none of Furukawa, Kai or Miyazaki, alone or combined, teach or suggest bonded wafers having the specific properties recited in claims 32 and 33. The bonded wafer of claim 32 generally corresponds to Example 2 in Table 1 of page 29 of the specification (see, for example, page 30, lines 5-11), and is produced by a process as defined in instant claim 25. Similarly, the bonded wafer of claim 33 generally corresponds to Example 1 of the specification (see, for example, page 31, line 18 to page 32, line 20), and is produced by a process as defined in instant claim 17. For all of the reasons described above, none of the cited references teach or suggest the claimed methods for making bonded wafers, and thus the references do not teach or suggest the bonded wafers themselves.

In order to have rendered obvious the claimed invention, the cited references must teach or suggest all of the limitations of the claimed invention. However, the present Office Action does not demonstrate how the references would have rendered obvious the claimed invention. In fact, the references would not have rendered obvious the claimed invention, for at least the reasons set forth above.

Accordingly, for at least these reasons, independent claims 32 and 33 are not taught or suggested by Furukawa, Kai, and Miyazaki.

3. Conclusion

Furukawa, Kai and Miyazaki, alone or in combination, would not have rendered obvious the claimed invention. Reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing amendments and remarks, Applicants submit that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below.

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Date: June 24, 2003

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